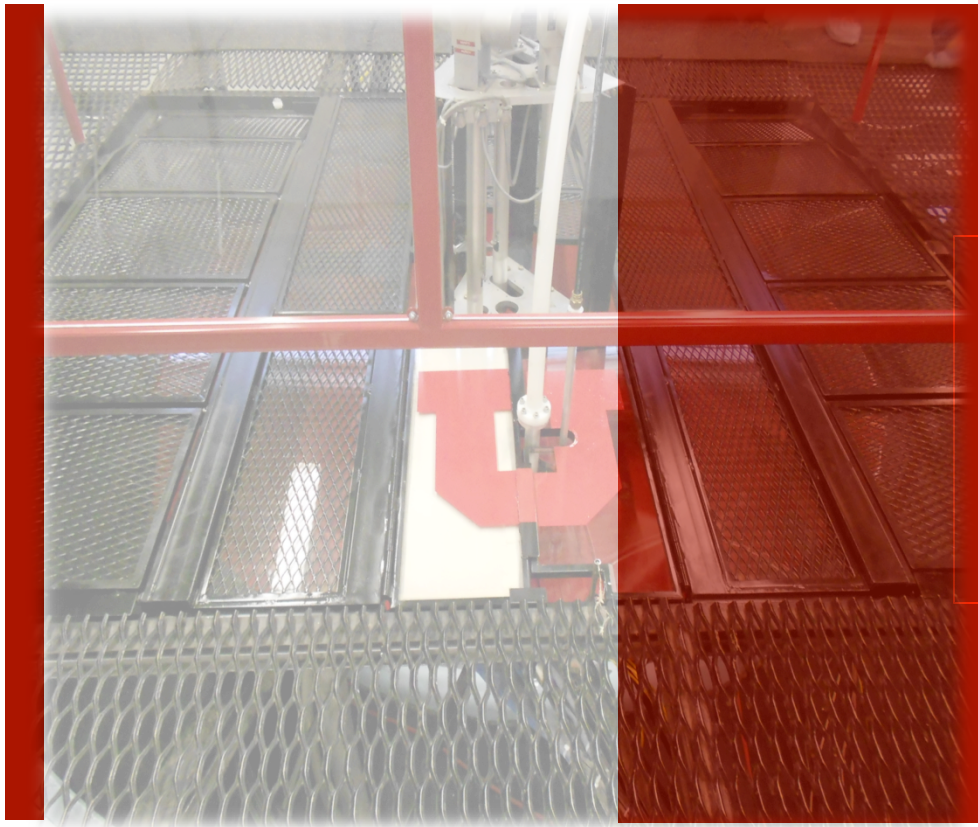


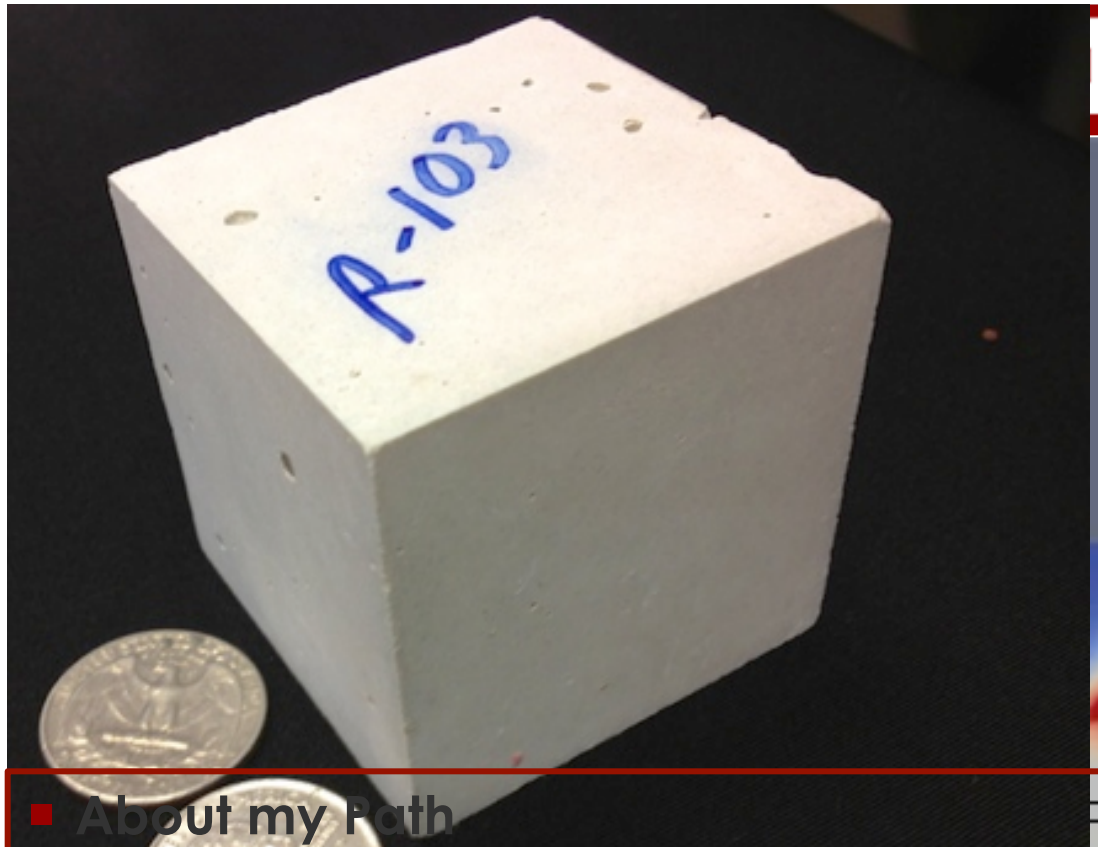
Nuclear Engineering
THE UNIVERSITY OF UTAH

Are We Ready for Nuclear Energy in UTAH?

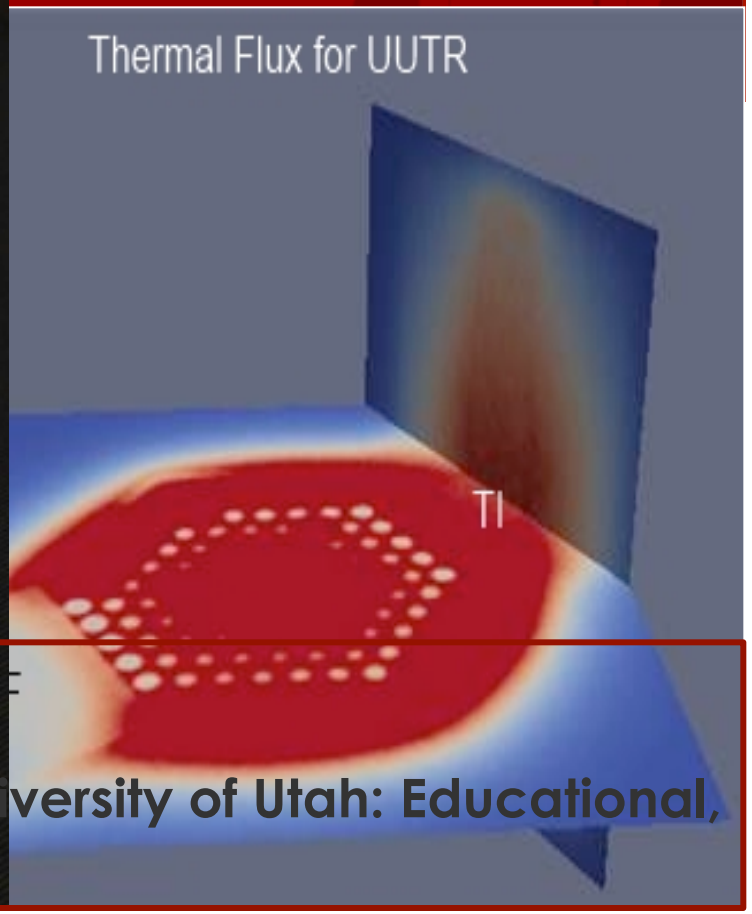
The University of Utah Nuclear Engineering Program Supports YES!

Dr. Tatjana Jevremovic
Chair Professor and Director of
Utah Nuclear Engineering Program
The University of Utah, Salt Lake City, Utah

Energy Summit, SLC, January 10, 2013



Nuclear Engineering
THE UNIVERSITY OF UTAH



- About my Path
- Nuclear Engineering Program at the University of Utah: Educational, Training and Research Capabilities

About My Path

Nuclear Engineering
THE UNIVERSITY OF UTAH

In 1990 to Japan

EDUCATION - in nuclear engineering

MS: University of Belgrade
BS: University of Belgrade

EMPLOYMENT:

Project Manager in Energoprojekt Co for 8 years

- Thermal &nuclear power plants environmental effects and systems designs
- Simulation and modeling
- Nuclear power plants site selection (IAEA)

In 2001 to USA

EDUCATION - in nuclear engineering

PhD: The University of Tokyo

EMPLOYMENT:

- Professor at the University of Tokyo for 2 years
  - Supercritical light water reactors designs
- Chief Engineer at Nuclear Fuel Industries, Ltd for 5.5 years
  - Reactor neutronics software development
  - In 2001 received the annual company award for the development of ANEMONA software
  - ANEMONA is a part of nuclear power plants' relicensing tools for BRW in JAPAN

About My Path

Nuclear Engineering
THE UNIVERSITY OF UTAH

EMPLOYMENT

2001 – 2009 Purdue University, West Lafayette, INDIANA
School of Nuclear Engineering
School of Health Sciences (courtesy appointment)
Adjunct professor in Division for Environmental and Ecological Engineering
Director NEGE Laboratory

Founder and Leader, Purdue Breast Cancer Research Group: new research in breast cancer treatment
Developed AGENT code, a sister of ANEMONA
Started developing new approaches in teaching for students retention in the field of nuclear engineering
Open the research in nuclear materials detection, virtual research reactor modeling, visualizations and space dose estimates for man missions to moon and beyond

EMPLOYMENT

2009 The University of Utah, Salt Lake City
EnergySolutions Presidential Endowed Chair Professor in Nuclear Engineering
Director Utah Nuclear Engineering Program (UNEP)
Professor of
Nuclear Engineering
Civil and Environmental Engineering
Chemical Engineering

Director of Nuclear Engineering Facilities: 100kW TRIGA and associated labs
Founder and Director of the Advanced Radiation Simulation Lab (ARSiL)
ANS & Alpha Nu Sigma Chapter Advisor
Promoter of nuclear engineering and science education and knowledge management in the world

We are called world-wide:

Nuclear Engineering
THE UNIVERSITY OF UTAH

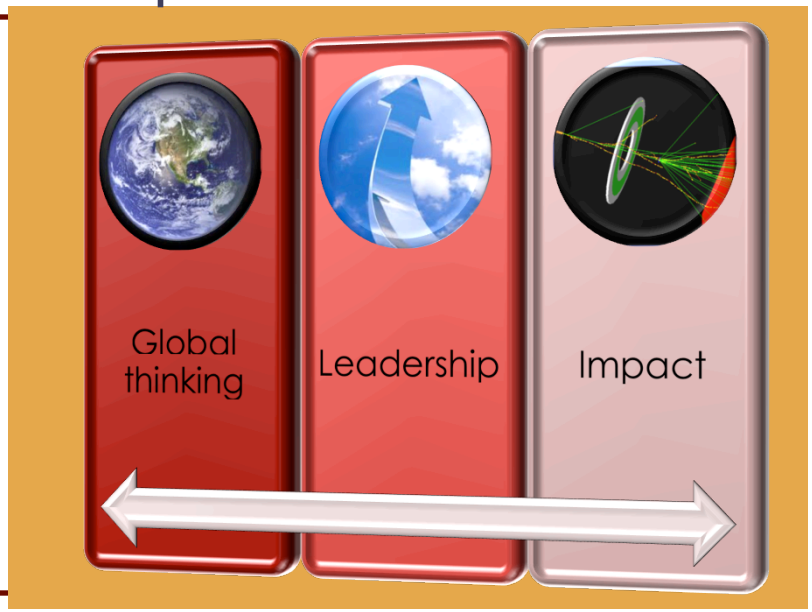
- **IAEA** in: Research Reactors; Advancements in NE Education and Preservation of Knowledge in NE; Neutron Sources
- **Uruguay**-
  - The first course on nuclear engineering delivered in May: **We broadcasted many labs from the University of Utah – Great model applicable to various educational systems**
  - Digital NAA practices (started in April, 2012)
- **Chile** -
  - **Courses and preparation of future teachers; joint labs**
  - **Virtual nuclear debates among students**
  - **Joint research / Digital NAA classes**
- **Argentina** -
  - **Exchanging research ideas / students / experts**
- **Serbia**- developing a masters program in applied nuclear sciences and engineering
  - **How to provide elementary training and curriculum materials, textbooks?**
- **Korea**
  - **Exchange of students and faculty / research**

Nuclear Engineering
THE UNIVERSITY OF UTAH

ABOUT UTAH NUCLEAR ENGINEERING PROGRAM (UNEP)
Revitalized and Modernized starting 08/2009

http://www.nuclear.utah.edu/nep.html with the mission

- **MINOR in Nuclear Engineering**
- **New Graduate Program**
- Advantages:
  - HANDS-ON experience: UNEF
  - New modernized program meeting the expectations of the 21st century nuclear industry!?
  - Cutting-edge research for all students

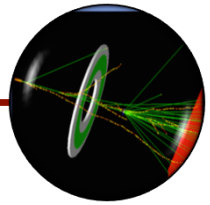


Provisioning the next generation staff
with high quality hands-on education & training for aspiring nuclear engineers, scientists and policy-makers

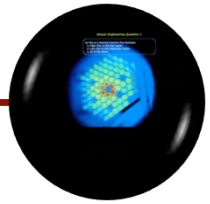
Nuclear Engineering
THE UNIVERSITY OF UTAH

UNEP interdisciplinary curriculum of national interest targeting the competency gaps in neutron-based engineering education:

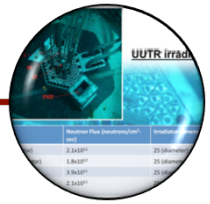
Modern Education, Training and Research



Nuclear Engineering Minor



Graduate MS & PhD Program



SRO & Lab Training

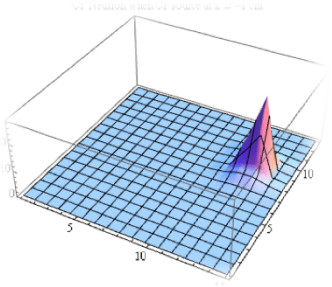
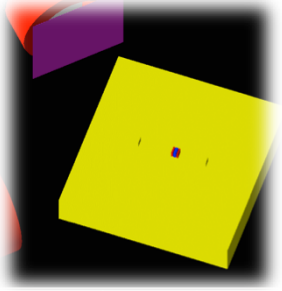
Bridging nuclear engineering and other disciplines at the U into nuclear engineering integrated studies with hands-on experiential learning

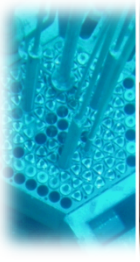
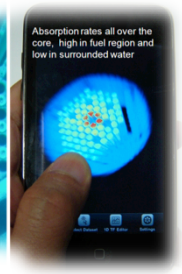
Unlock the world with neutrons!

Nuclear Engineering
THE UNIVERSITY OF UTAH

UNEP interdisciplinary curriculum of national interest targeting the competency gaps in nuclear engineering education



- TRIGA
- Labs

Hands-on experience

Forensics

- Radio – chemistry
- Nuclear Medicine

- Nuclear environmental engineering

Waste engineering

Homeland security

- SNM
- Detectors
- Materials

- NE codes
- NAA

Industrial preparedness

With new teaching and training techniques

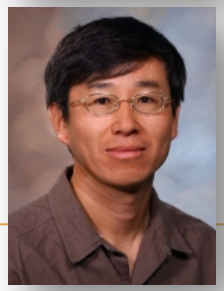
Nuclear Engineering
THE UNIVERSITY OF UTAH

UNEP MAIN FACULTY

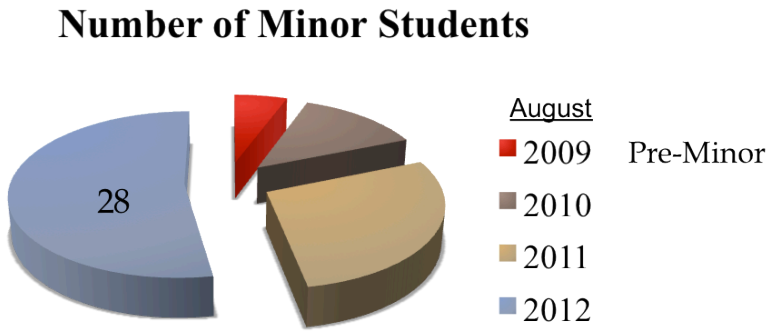
08/2009 ~
Tatjana Jevremovic
Chair Professor and UNEP Director

01/2011 ~
Haori Yang
Assistant Professor

Dong-OK Choe
Reactor Supervisor



Number of Students in UNEP



National Level Comparison for 2012: Our success!

Program	Number of faculty	Number of graduate students
UNEP	2 (3)	29
Penn State	11	50
Ohio State	7	35
Illinois Urbana	11	70

Top 15 ranked programs in the USA

17 MS
12 PhD

As of December 2012: 6 MS and 1 PhD graduated!

Spring 2013: 3 new MS students admitted

NEW! Only at UNEP!

Nuclear Engineering
THE UNIVERSITY OF UTAH

New UNEP Graduate Program

Nuclear Forensics Track

Thesis MS → PhD Degree!

THE UNIVERSITY OF UTAH

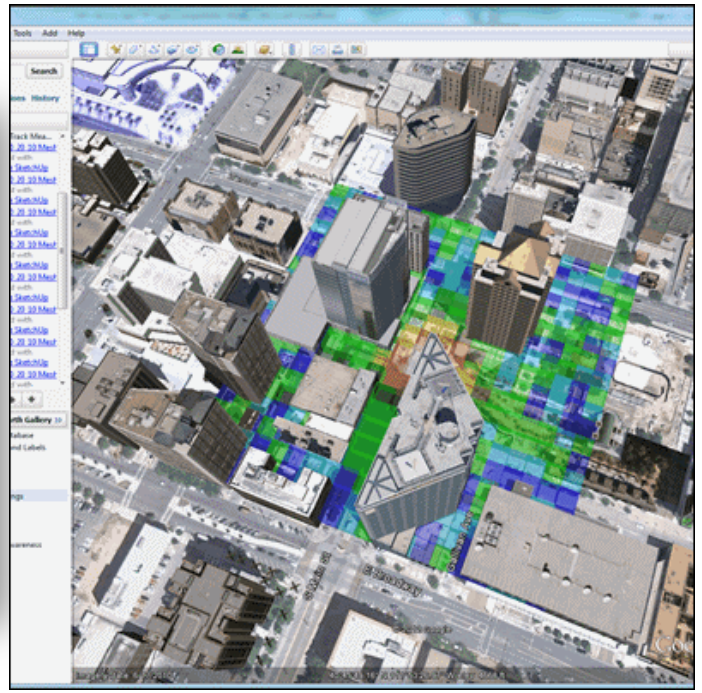
Nuclear Forensics at the University of Utah

Cross Disciplinary Research Studies and the New Graduate Education Program

PI: Dr. Tatjana Jevremovic, Chair Professor and Director Utah Nuclear Engineering Program
Co:Pis: Drs. Terry Ring, Charles Grissom and Xuesong Zhou

2010 - 2013

Academic-Lab Collaboration Meeting, Aiken, SC, 11-12, April, 2011



NEW!!

Nuclear Engineering
THE UNIVERSITY OF UTAH

New UNEP Graduate Program

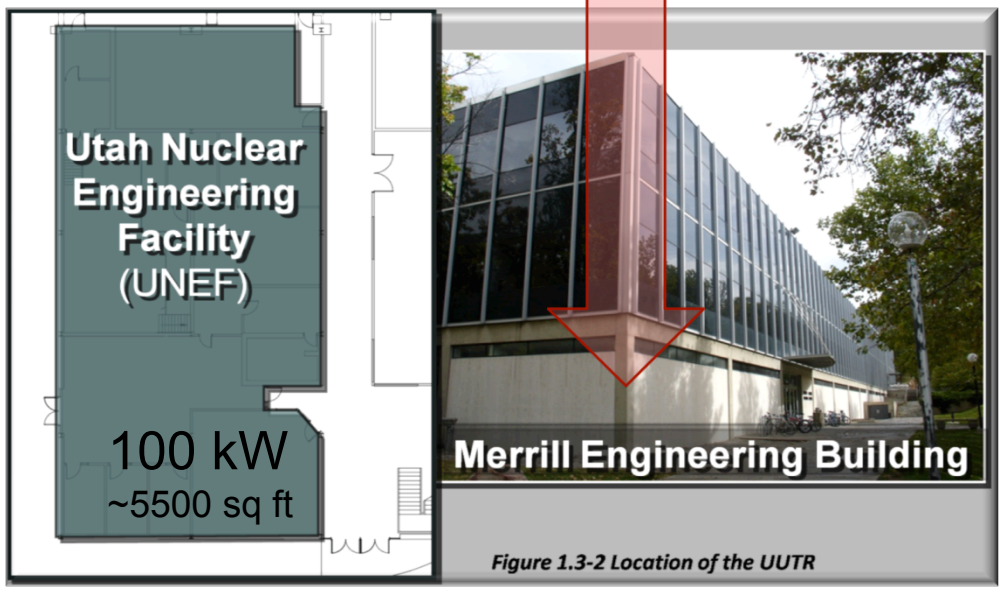
Nuclear Environmental Engineering Track

Under development…

Nuclear Engineering
THE UNIVERSITY OF UTAH

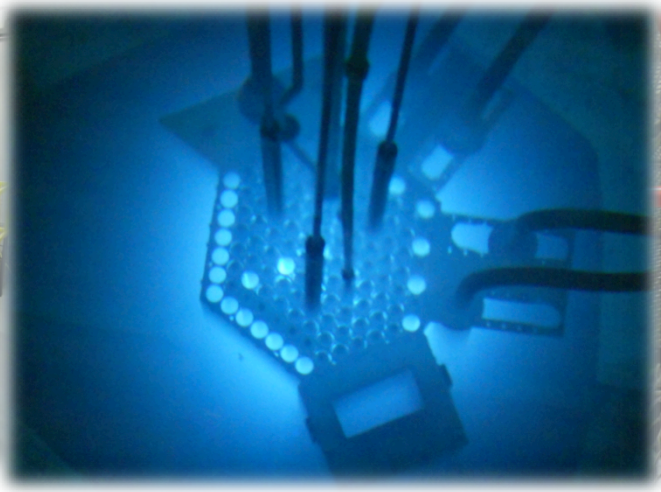
UNEP Facilities

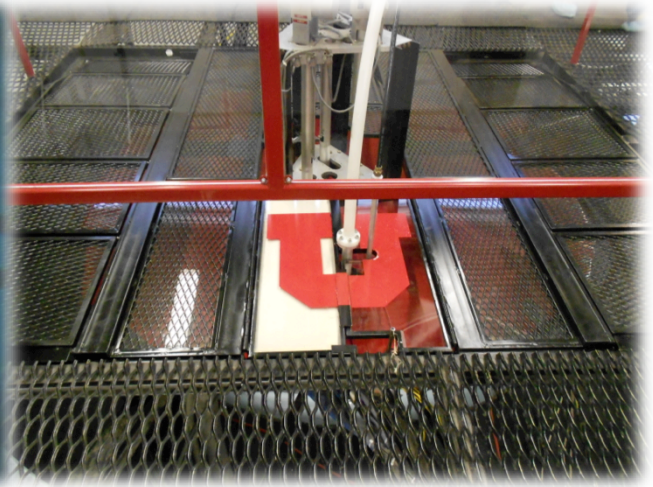
UNEP Facilities



Nuclear Engineering
THE UNIVERSITY OF UTAH

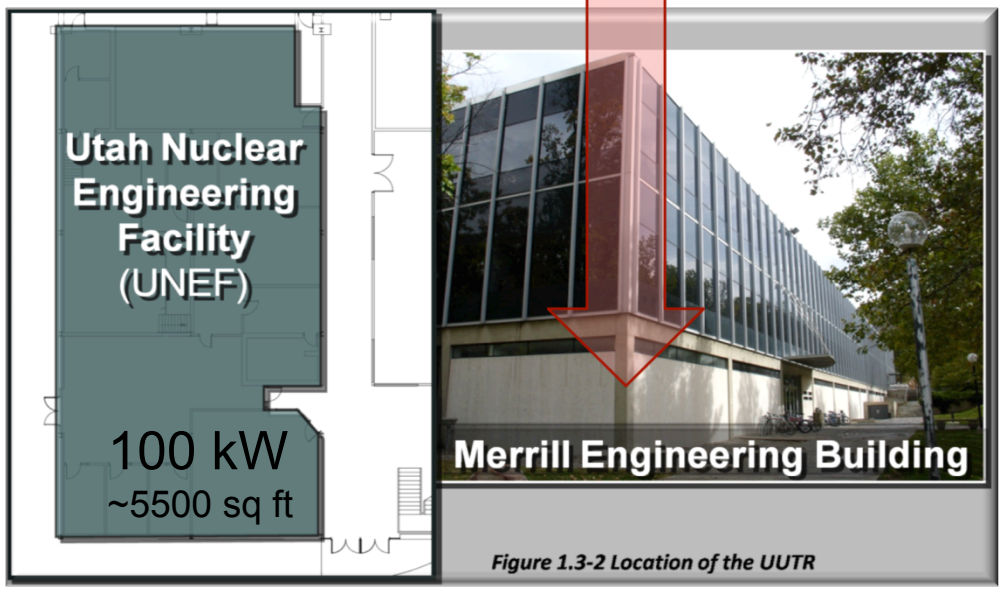
Blue Wing





UNEP Labs

Nuclear Engineering
THE UNIVERSITY OF UTAH

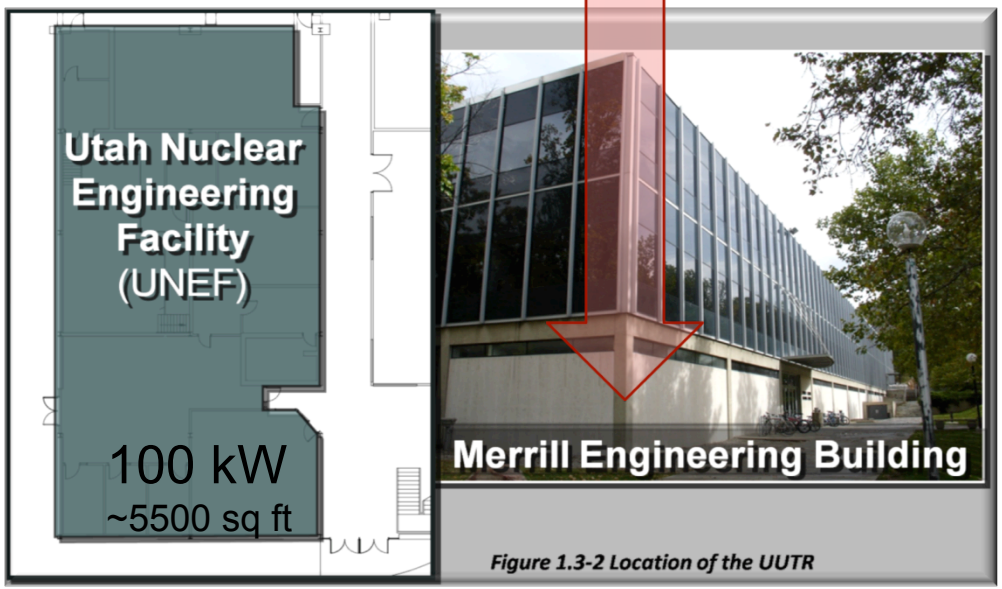


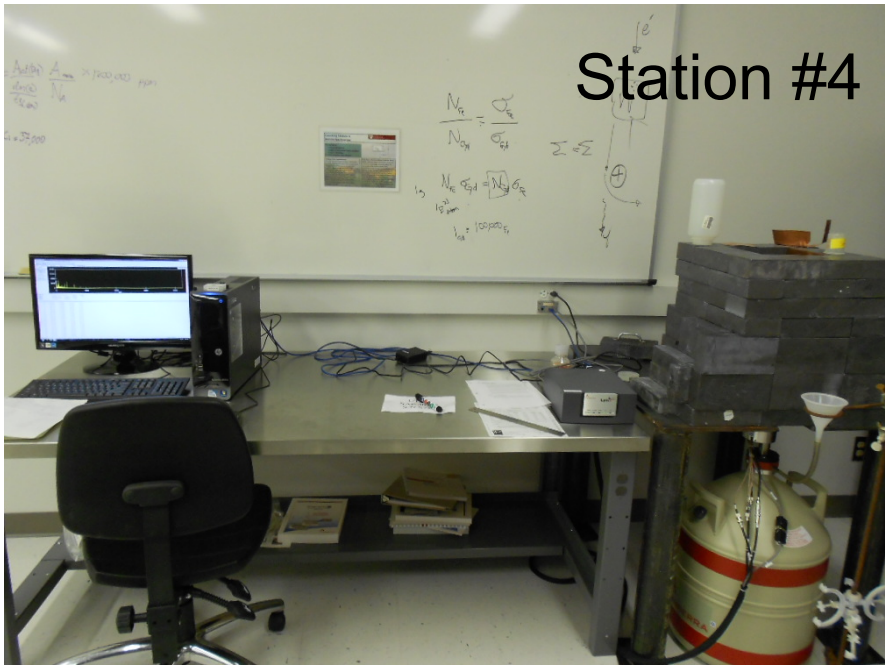
White Wing

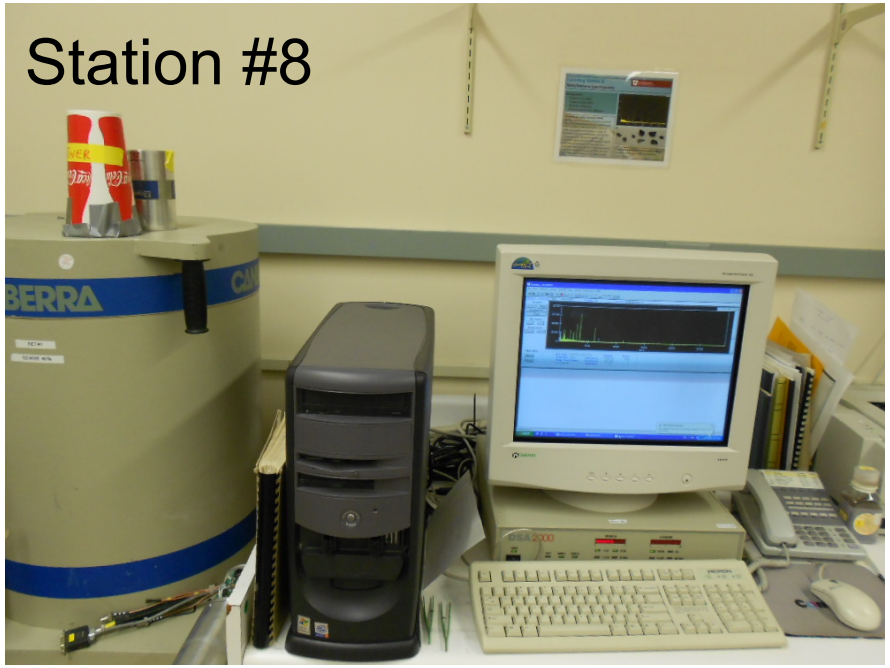
UNEP Labs

Nuclear Engineering
THE UNIVERSITY OF UTAH

8 Counting Stations







White Wing

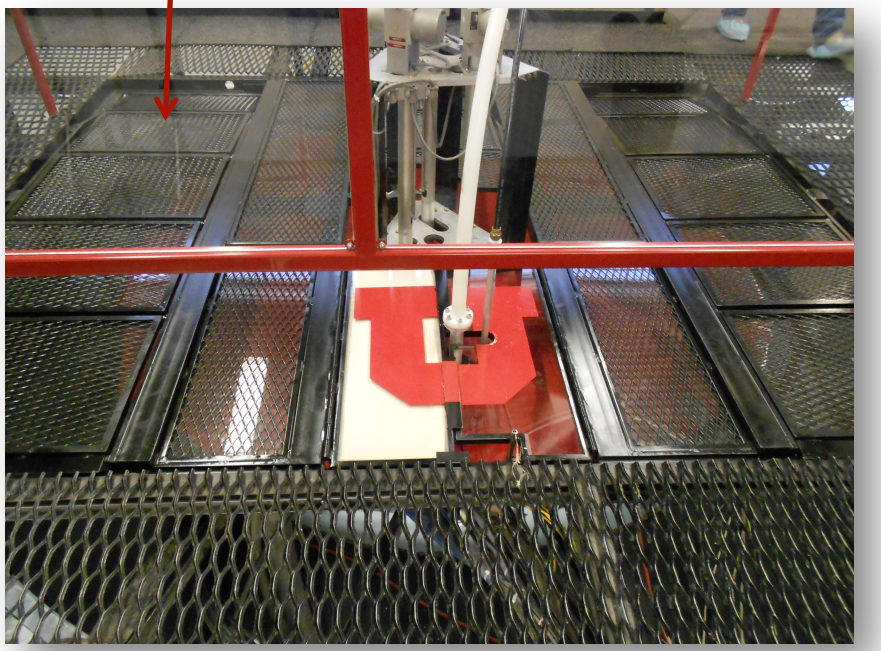
Nuclear Engineering
THE UNIVERSITY OF UTAH

TRAINING PROGRAMS

Nuclear Engineering
THE UNIVERSITY OF UTAH

UNEP Infrastructure: Training

NEW!



5 SROs

- TRIGA Reactor housed in the UNEP is established as a university-wide facility to promote **research, education and training** in nuclear engineering, radiation science and health physics.
- The UNEP curriculum includes classes that maximize the utilization of UUTR
- In addition: two consecutive graduate level classes in preparing students for the **reactor operation license.**
  - Practical training to operate the research reactor gives the students experiential understanding of the "how" and "why" pertaining to reactor physics.

Nuclear Engineering
THE UNIVERSITY OF UTAH

UNEP Practices

Facility – SAFETY DISCIPLINE!!!!!

Not enough!

Nuclear Engineering
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SOMETHING UNIQUE with DevonWay!

DevonWay's innovative continuous improvement software is changing the way nuclear and other power-generation plants respond to cross-cutting issues and regulatory compliance.

Now, DevonWay is extending continuous improvement across all Enterprise Asset Management (EAM) processes. Whatever your plant or fleet's system of record is today, DevonWay has a better way to support operations, engineering, and maintenance processes.

http://www.devonway.com/

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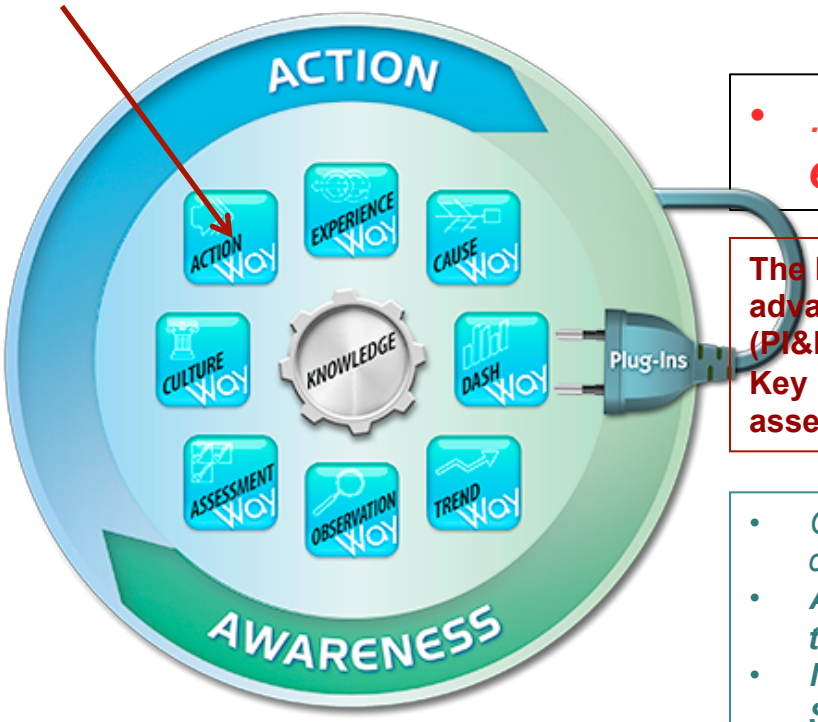
DevonWay Approach:



- ***."An accident anywhere is an accident everywhere"***

The DevonWay Continuous Improvement Suite supports and advances corrective action, problem identification and resolution (PI&R), operating experience, human performance improvement, Key Performance Indicators (KPIs), trend analysis, operational assessments, employee recognition, and root-cause analysis.

- *Convergence between academia and industry (referred to methods, content, tools …)*
- ***Adjusting the development of nuclear education to new technical and social realities***
- ***New realities in Scientific, Technological and social life of Society should be reflected in the content and tools of Nuclear Education.***

http://www.devonway.com/

Nuclear Engineering
THE UNIVERSITY OF UTAH

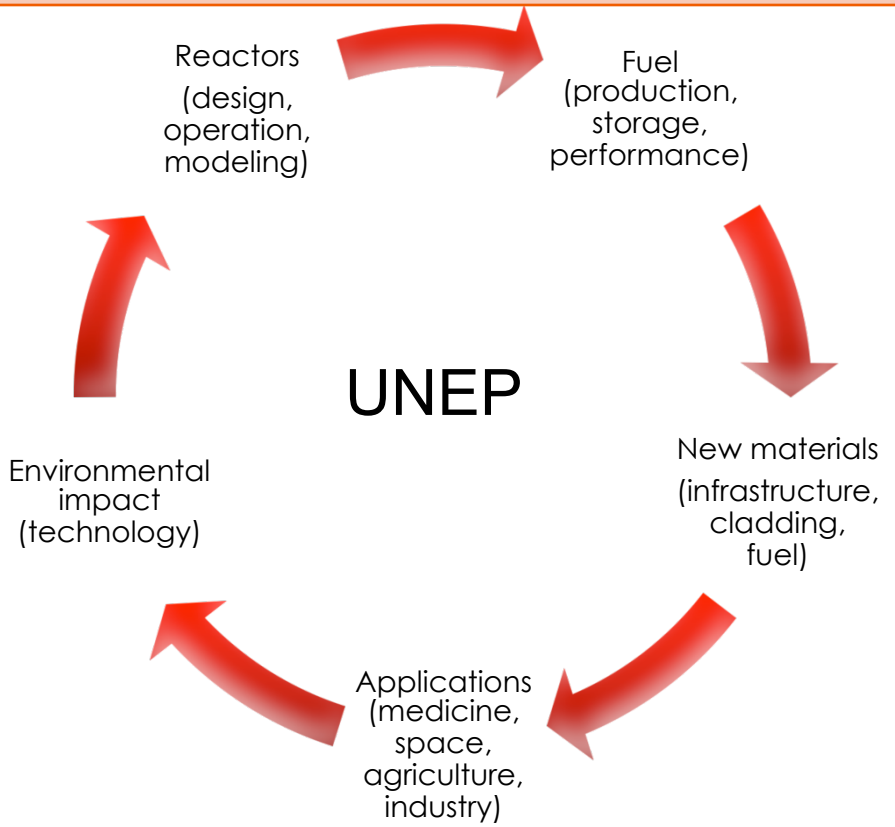
DevonWay at UNEP: **Track & Trace**

Students learn new culture

Type 1	**Purchasing**	Track every request and order
Type 2	**Incidents**	Complex line of reporting simplified and organized for easy tracking
Type 3	**Maintenance**	Two facility wings with own flow chart for tracking the requests and repairs

Nuclear Engineering
THE UNIVERSITY OF UTAH

RESEARCH & EDUCATION FOR NUCLEAR JOBS - SNAPSHOTS



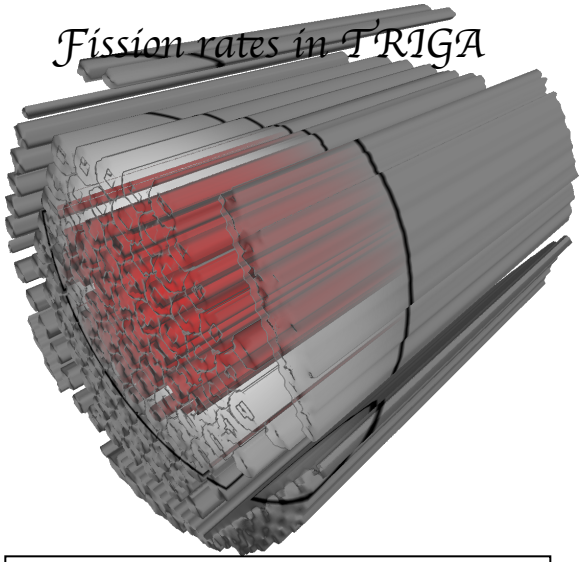
Educate and train the students, and participate in new rector designs

ARBITRARY GEOMETRY AGENT NEUTRON TRANSPORT

Nuclear Engineering
THE UNIVERSITY OF UTAH

Mathematics + Physics + Computer Science → REACTORS

Fission rates in TRIGA



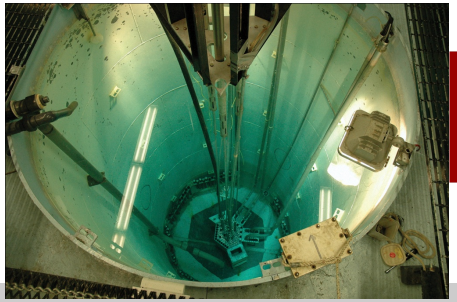
Use TRIGA measurements to benchmark AGENT and other codes

2D/3D AGENT

Method of Characteristics solution to neutron transport equation & **R-functions theory** for geometry description

-Isotropic & anisotropic scattering
-Double heterogeneity
-Any reactor type: PWR, BWR, HTGR, TRIGA, MTR
-Extensive visualizations
-Experiential learning tool

AGENT Model of our TRIGA



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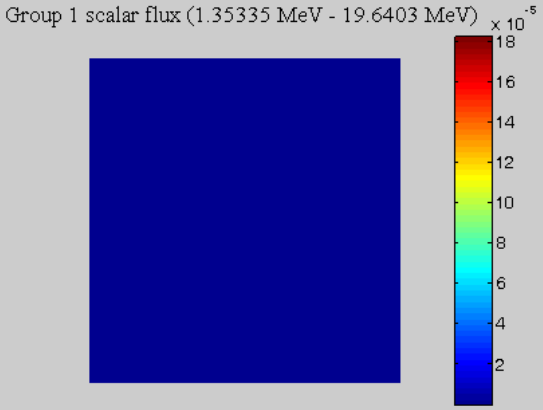

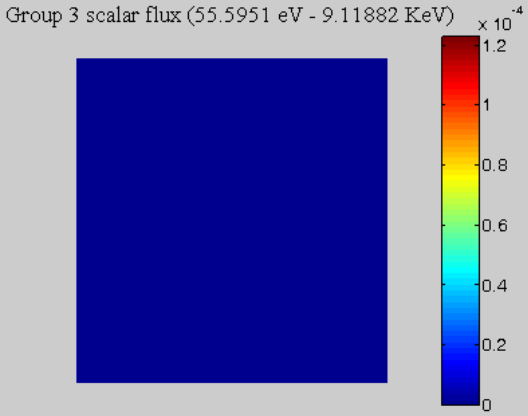

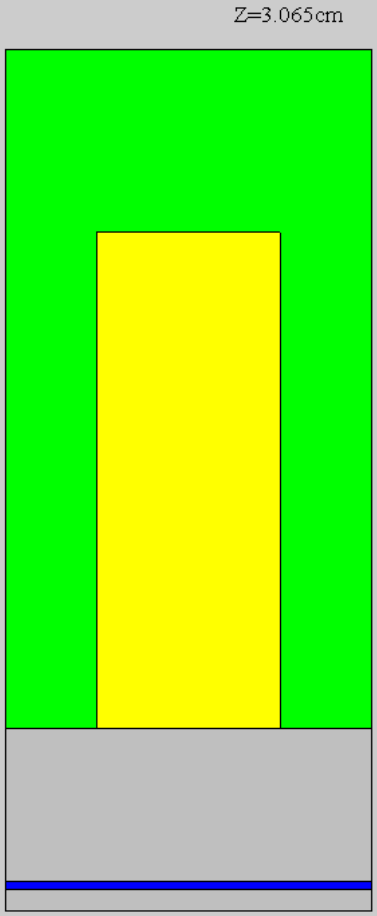

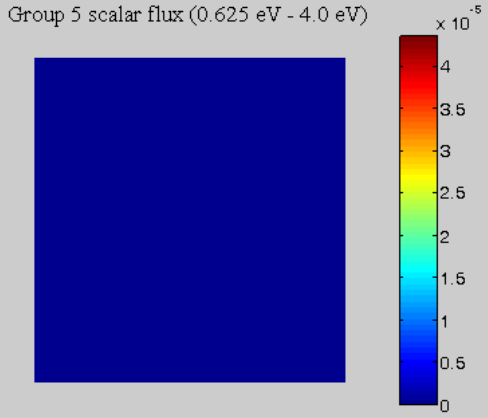

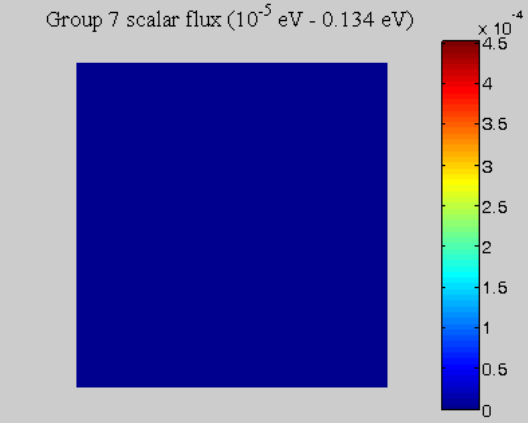

Advanced Visualizations & Use of Mobile Technologies

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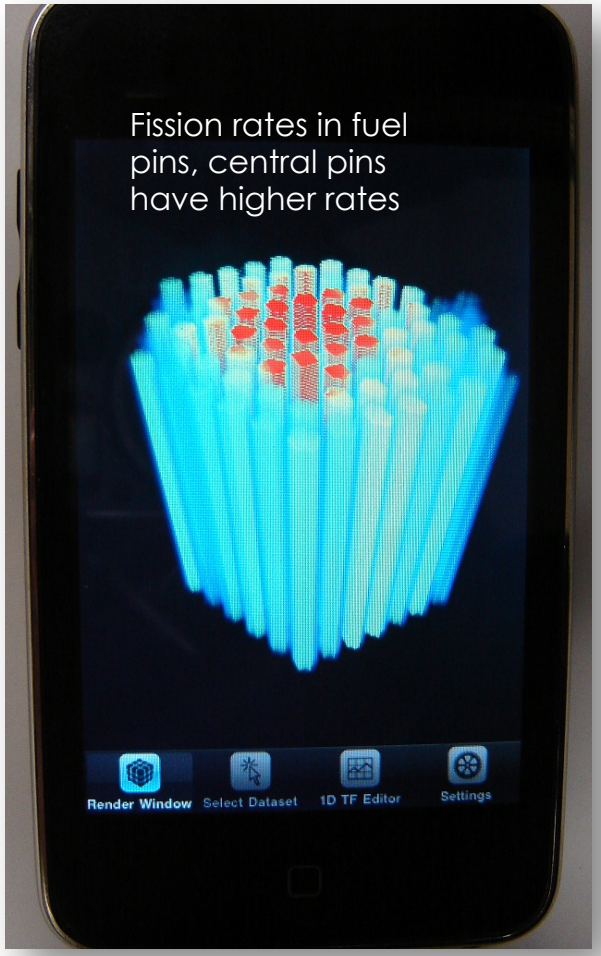
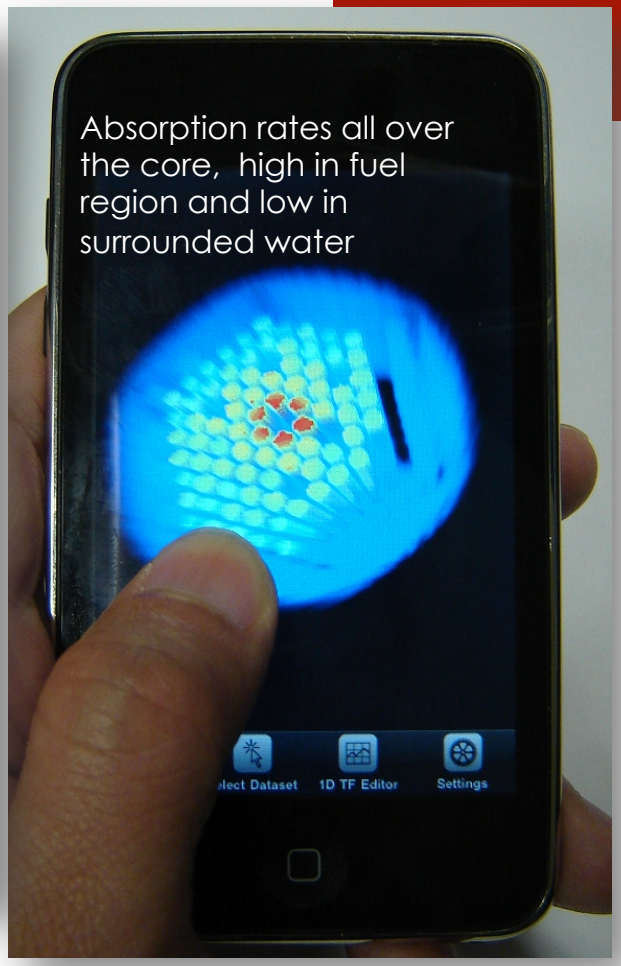




Fission Rate

Absorption Rate

ROLE OF NUCLEAR ENGINEERING IN Nuclear Forensics at the University of Utah

Cross Disciplinary Research Studies and the New Graduate Education Program

PI: Dr. Tatjana Jevremovic, Chair Professor and Director Utah Nuclear Engineering Program
Co:Pis: Drs. Terry Ring, Charles Grissom and Xuesong Zhou
2010 - 2013

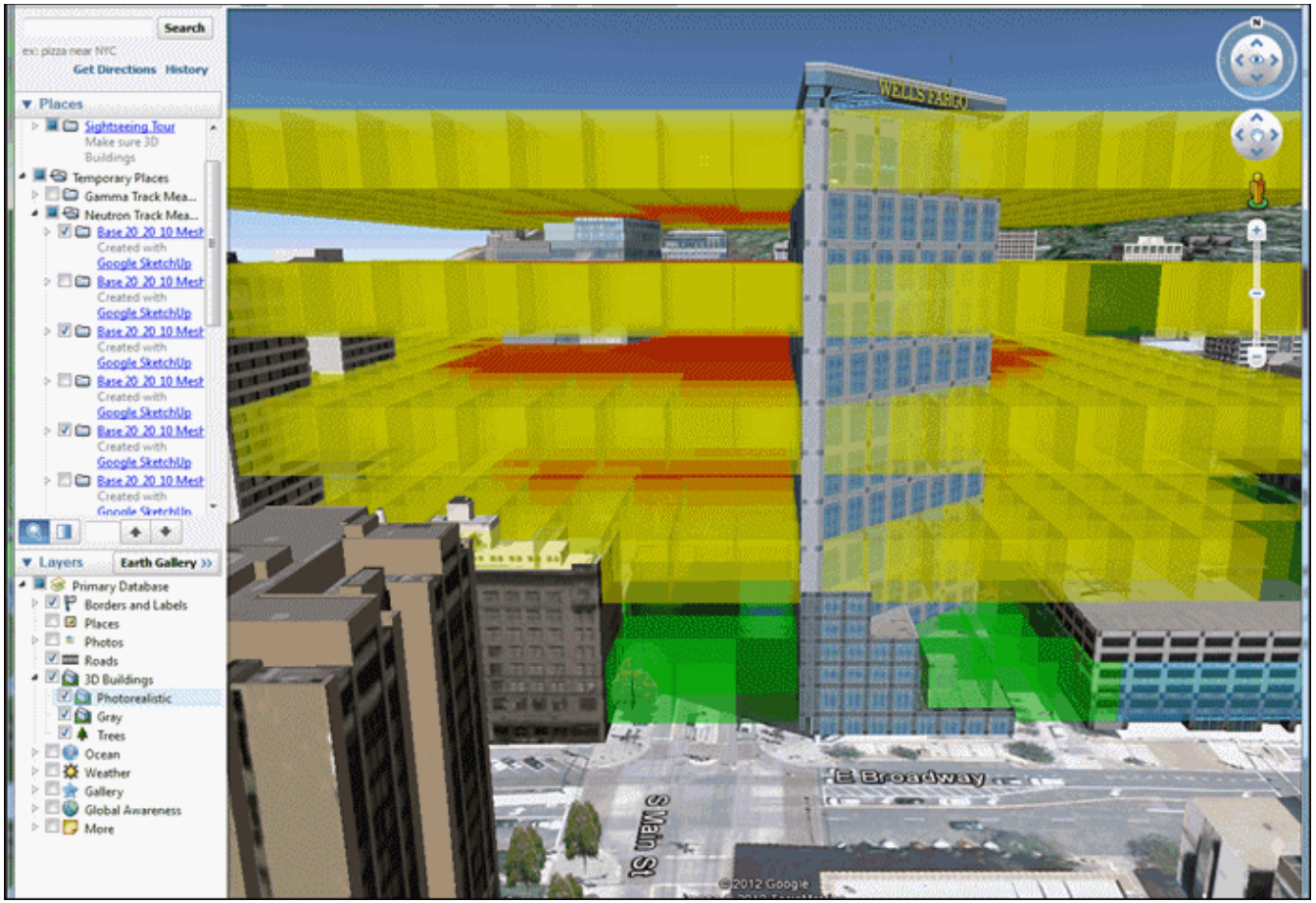
THE ONLY Graduate Program in Nuclear Forensics in USA
@ the University of Utah Nuclear Engineering Program

NUCLEAR FORENSICS

THE UNIVERSITY OF UTAH

Nuclear Forensics in Urban Settings

Merging GEANT4 and GoogleEarth

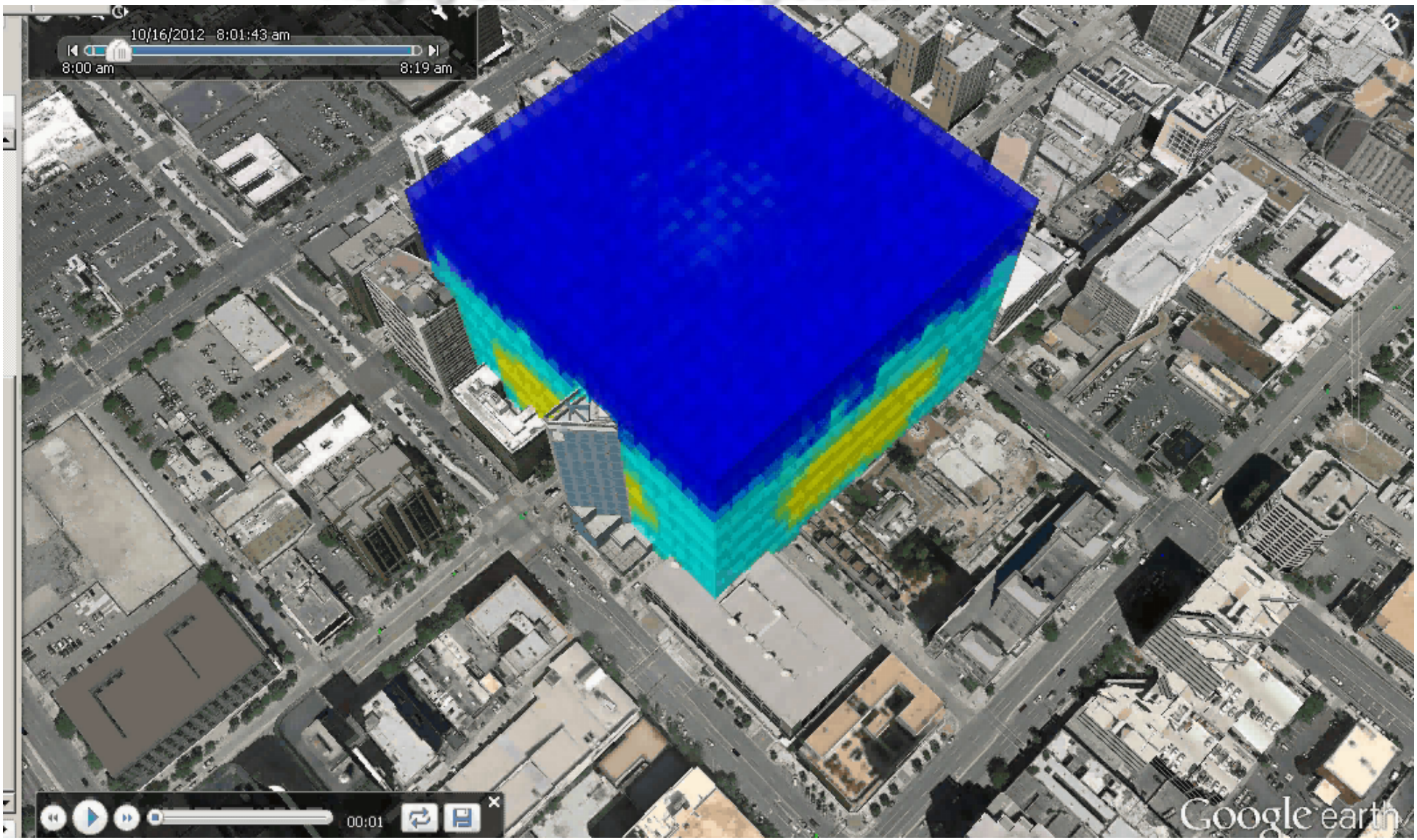


NUCLEAR FORENSICS

THE UNIVERSITY OF UTAH

Nuclear Forensics in Urban Settings

Merging GEANT4 and GoogleEarth



ROLE OF NUCLEAR ENGINEERING IN TREATMENT OF CANCER

Everyone on Earth either:

- Has/had a cancer
- Knows someone who has/had cancer and lives
- Knows someone who had cancer and did not win

Our lives are touched by those who fights the cancer!

And, among all cancers, the breast cancer takes a lead, worldwide!

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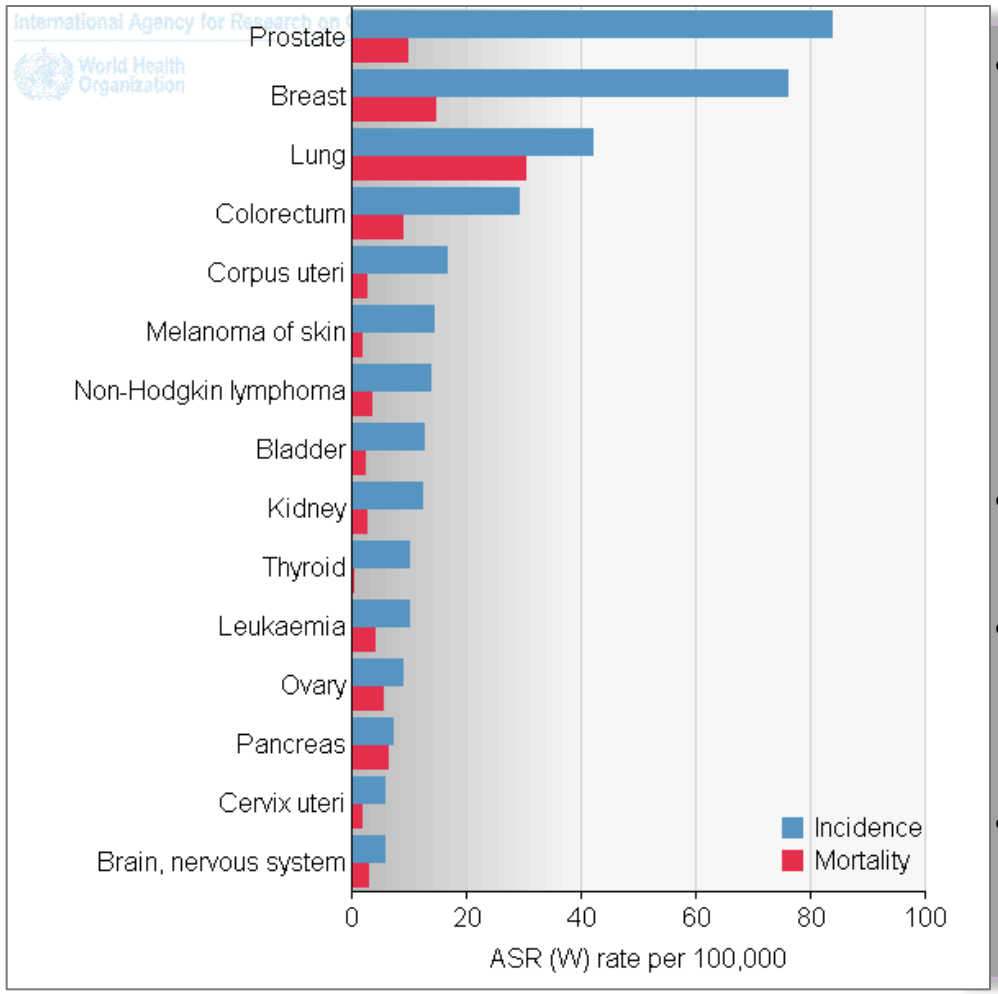
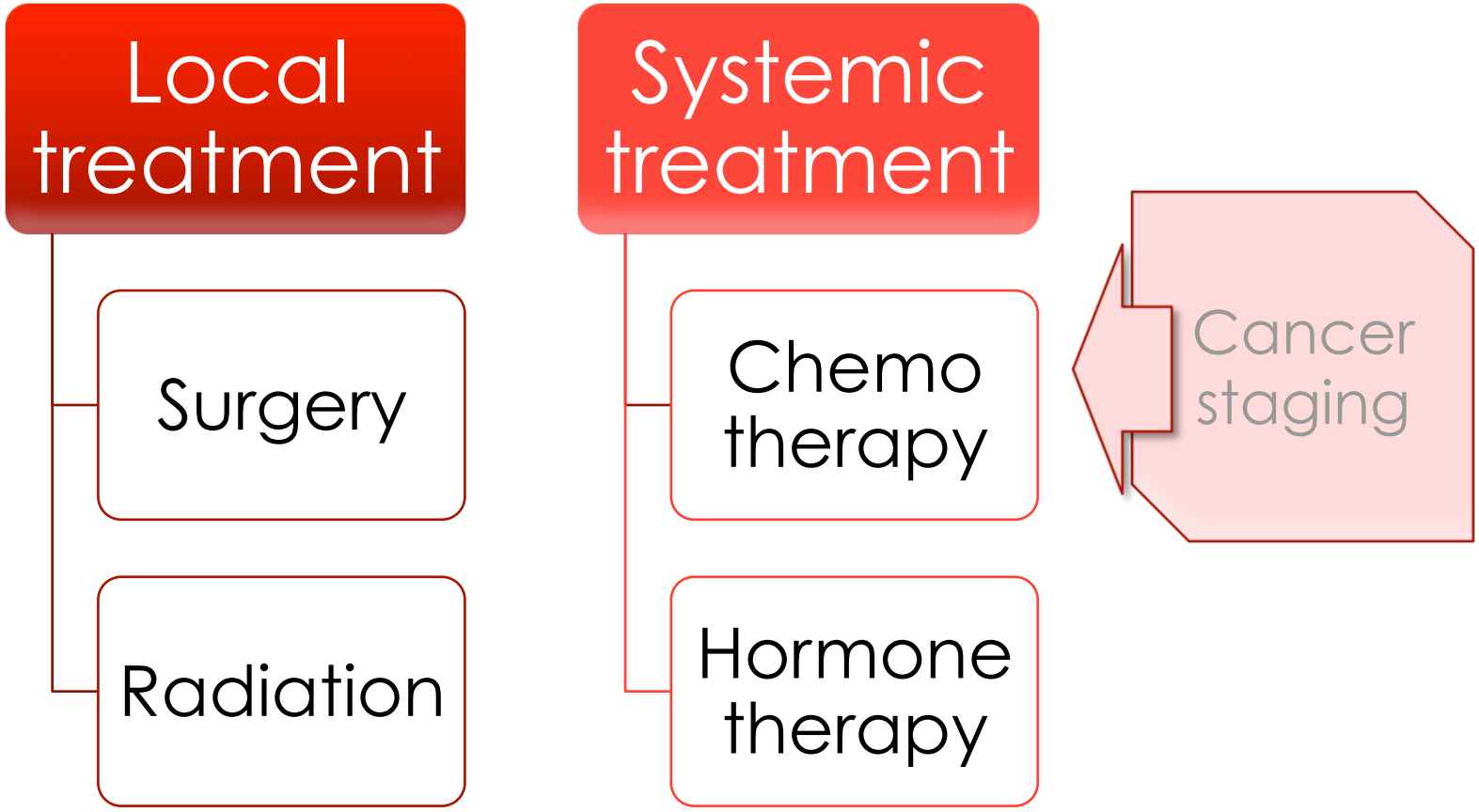
Breast Cancer in the U.S.A.



- According to the National Cancer Institute in the USA
  - 1 of every 8 women develops a breast cancer during her lifetime
  - Approximately 40,000 women die each year in the U.S. alone due to breast cancer
- 30% of incidences are detected *after* metastasis
- **30% are HER2+ (aggressive)**
  - **There are other HER2+ cancers**
- Stage IV treatment options are limited and are only about 10% effective in curing the disease

Breast Cancer Treatment Protocols



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How the BNCT for Breast Cancer Treatment can become a Complementary to Current Protocols?

Local treatment

Spare the tissue

Surgery

Radiation

Reduce the duration and dose

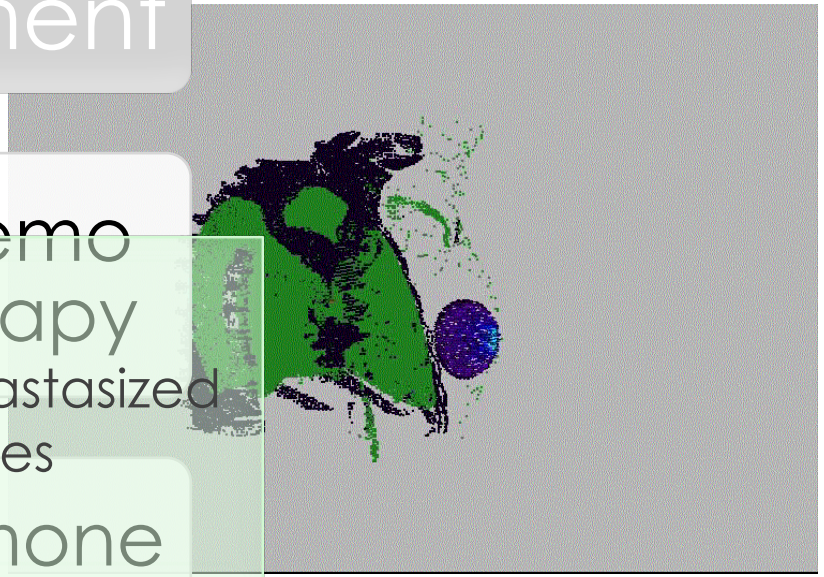
Repeatability!

Systemic treatment

Chemo therapy

Treat metastasized cases

Hormone therapy



Nuclear Engineering
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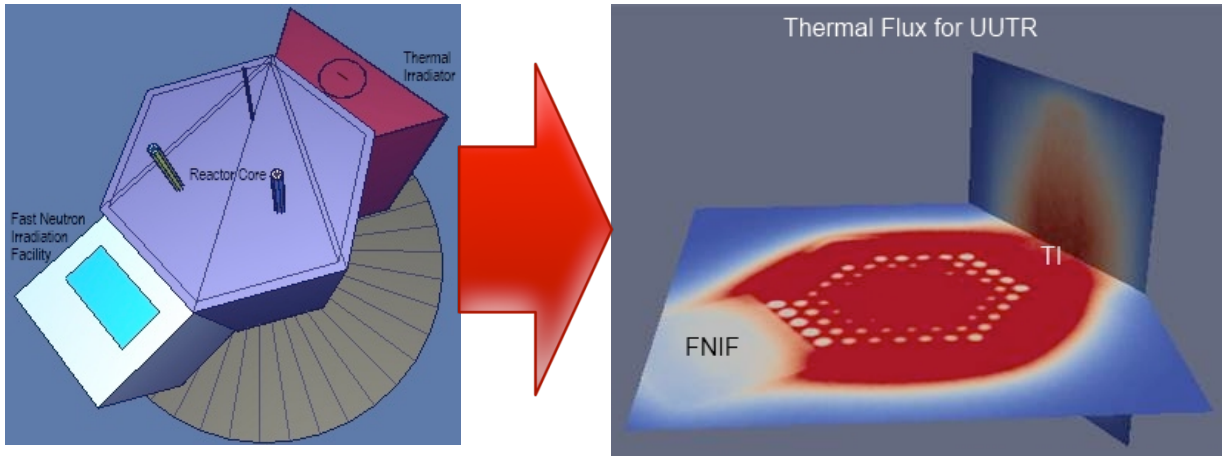
NEOPANORA funded research
August 2012 ~ August 2015
~ $500,000
With Profs. Magda and Grissom

- Two new pharmaceuticals (smart gels and Herceptin-based
- Optimization of neutron sources: for cell-line to clinical trials
- Optimization of UUTR facility for cell-line and pharmaceuticals' tests



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Neutron Activation Analysis

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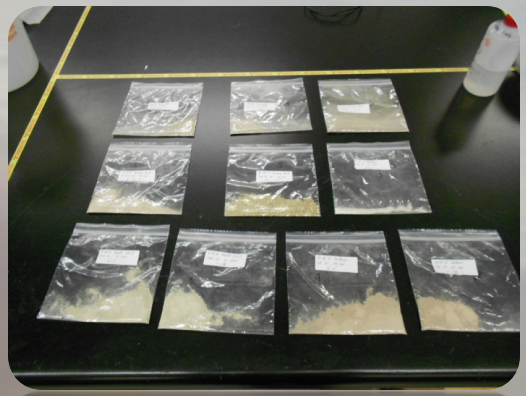
What do We Use NAA for:

- Environmental studies: Great Salt Lake pollution
- Crime forensics
- Trace elements to explain earthquakes
- Lime stones
- Meteorites
- Developing new materials for nuclear industry (concrete and composite structure)
- Quality of soil in increasing the crops production: cherry farms in the State of Utah & wines
- Food analysis

Geology and Environmental Engineering

Historical Records tru NAA

Core Samples of Great Salt Lake: Defining Evolution of Pollution?



Experimental Engineering:
Neutron Activation Analysis

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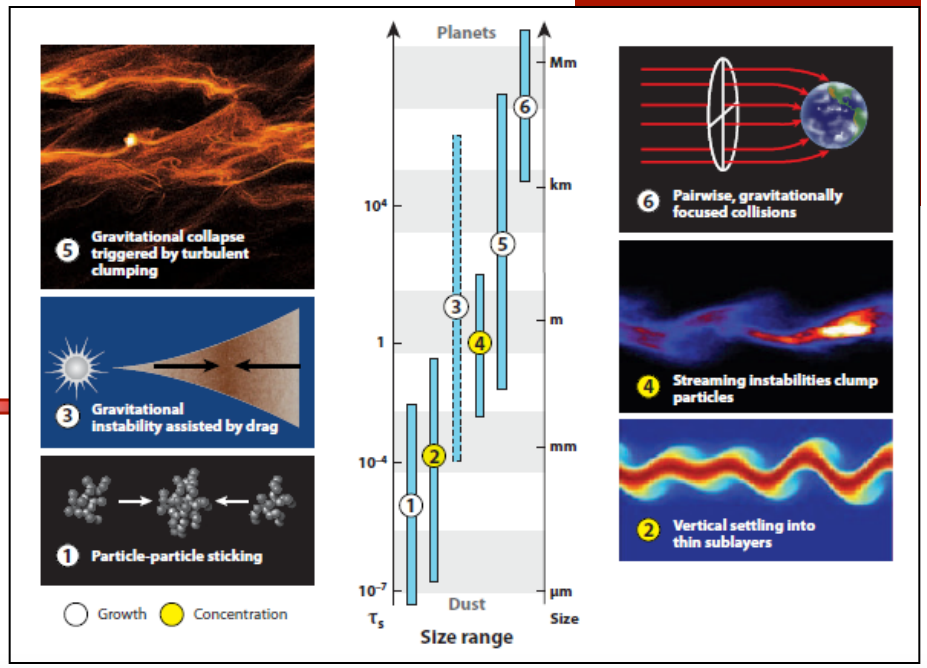
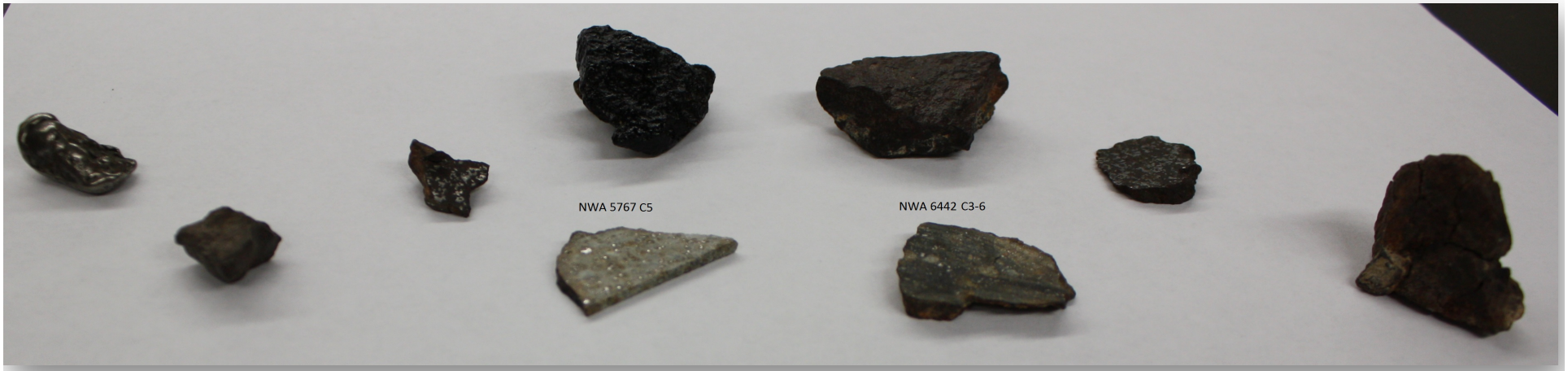
Solar system and beyond



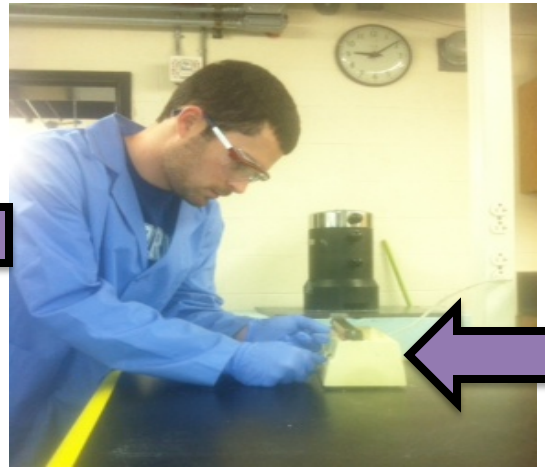


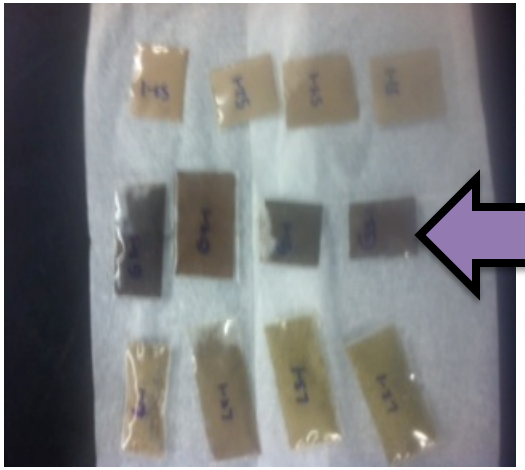
UNEP's private meteorite collection photographed from left to right: Campo del Cielo, B5-1231, NWA 6436, Tektite, NWA 5767, Ghubara, NWA 6442, NWA 6450, B5-1218

AGRICULTURE
Grape Cycle

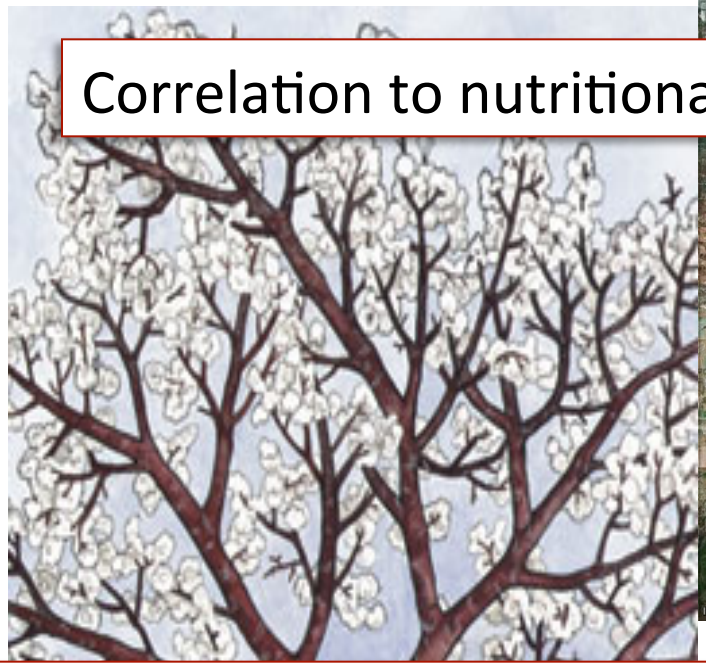
Vineyard sampled in Oregon

Test nutrient distribution throughout grape system

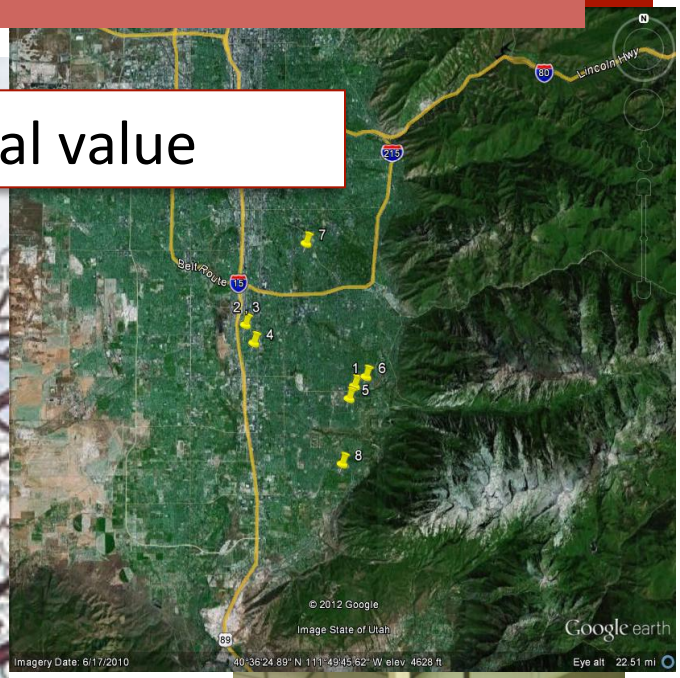




Cherry Cycle



Correlation to nutritional value



Distribution throughout structure

Soil affect on tree health

New Idea?

Radiation Resistant Concrete

Multiple Concrete Suppliers

Multiple local aggregate sources

Multiple Portland cement producers

- Requires developed aggregate sources
- Coordinated efforts with structural concrete producers
- Specific requirements for Portland cement manufacturing
- Testing criteria and facilities to develop and verify new concrete performance

Limited Sites for LLRW Storage in the U.S.

- Energy Solutions – Barnwell, S. Carolina
  - Beginning in 2008 – only accepts waste from the Atlantic compact states.
  - Licensed for Class A-C type waste.
- US Ecology – Richland, Washington
  - Richland accepts waste from the Northwest and Rocky Mountain compact states.
  - Licensed for class A-C type waste.
- Energy Solutions – Clive, Utah
  - Approximate size 1 sq mile.
  - Limited area for LLRW
  - Accepts waste from all regions.
  - Licensed for Class A waste only.

- Utah, Clive facility handles over 95% of the LLRW processed in the U.S.
- No new LLRW waste sites have been developed since 1985.

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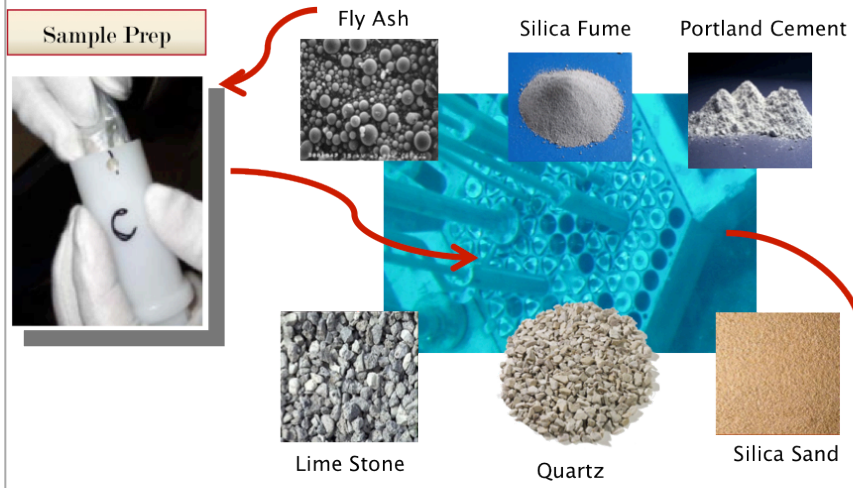
New Concrete for Nuclear Power Plants and Fuel&Waste Storages

Radiation-Resistant Concrete Design

How Radioactive is Our US Concrete?

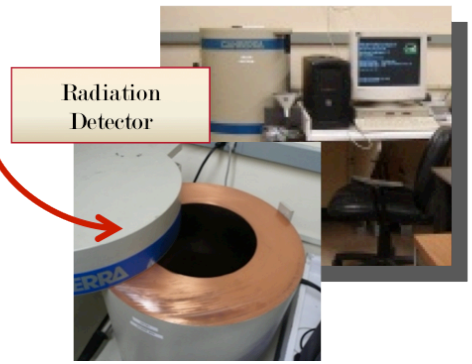
Current Target Aggregates Identified

Concrete produced Inter-Mountain West (Wasatch Front, UT) currently uses natural aggregate sources that are targets for Low Neutron Activation Design, such as:

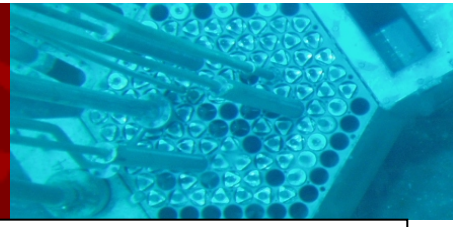


Neutron Activation Analysis (NAA)

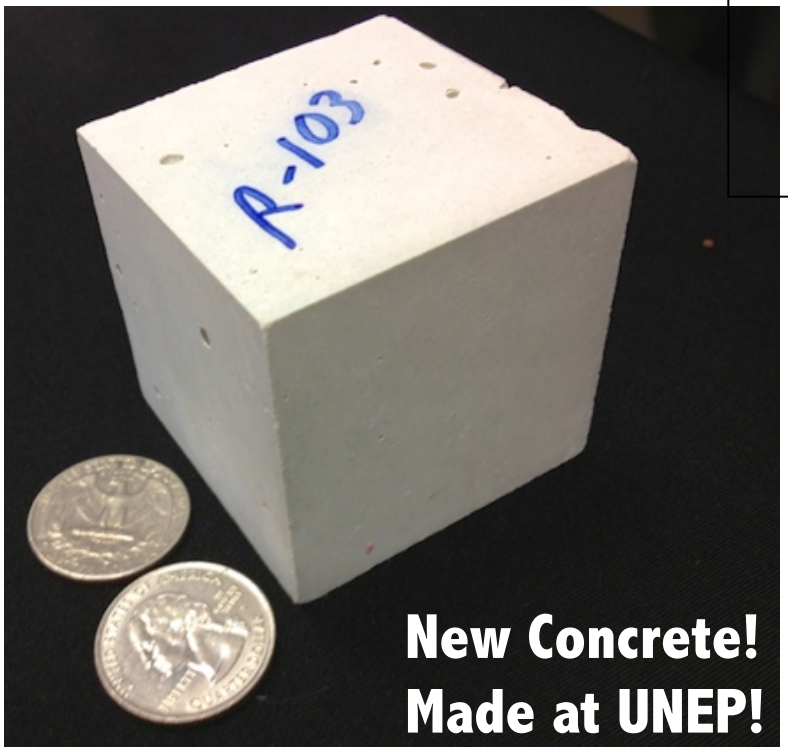
- Each selected component is irradiated in order to undergo a gamma spectrum analysis
- Element composition is identified in amounts of ppm.
- Sample activity is known.

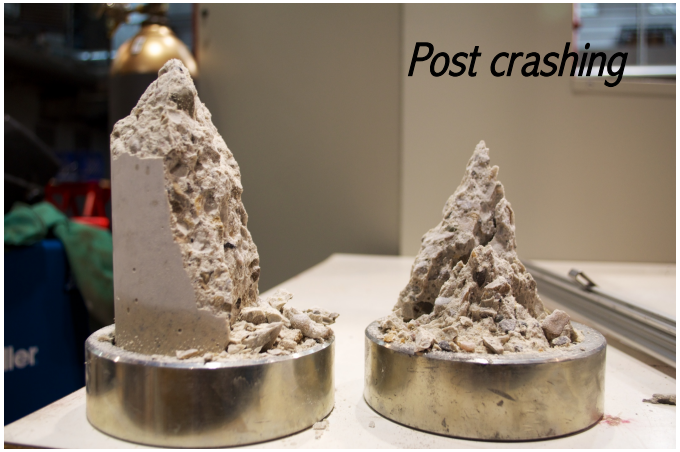


- Concrete mix designs & Criterion for concrete design life
- Sample analysis of concrete mixes & Modeling of selected components
- Irradiation of component samples & Structural testing



- Created first trial batch July 2012
- Small concrete cubes used for irradiation in UNEF TRIGA Reactor
- Cylinders to test for compressive strength
- Benchmarking MCNPX simulation with experiments





Changing Nuclear Energy Environmental Signature


Thank You
&
See You Tomorrow
at UNEP